# Practice MCAT Test II

## Physical Sciences

**Passage IV**
Glycine is an amino acid with the formula $H_2N$-$CH_2$-COOH. The $pK_a$ of the -COOH group is 2.3 and the $pK_a$ of the $-NH_3^+$ group is 9.6. The isoelectric point is at pH 6.0.

**28.** Glycine is predominantly deprotonated at
**A.** pH > 2.3
**B.** pH > 6.0
**C.** pH > 7.0
**D.** pH > 9.6

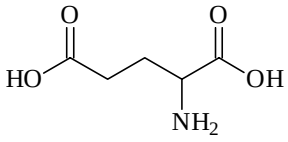
**29.** Which functional group in glycine is the strongest acid?
**A.** $-NH_3^+$
**B.** -COOH
**C.** $-CH_2-$
**D.** None of the above

**30.** At which pH's does glycine exhibit the most buffering
effect?
**A.** 6.0 and 9.6
**B.** 2.3 and 6.0
**C.** 2.3 and 9.6
**D.** 6.0 and 7.4

**31.** The pH of cytoplasm is about 7.2. Which form of glycine
predominates in cytoplasm?
**A.** $H_3N^+$-$CH_2$-$COO^-$
**B.** $H_2N$-$CH_2$-COOH
**C.** $H_3N^+$-$CH_2$-COOH
**D.** $H_2N$-$CH_2$-$COO^-$

**32.** A small quantity of glycine is placed in a buffer solution of pH 2.0 and an electrical field is applied. What will happen to the glycine sample?
**A.** It will migrate to the anode.
**B.** It will migrate to the cathode.
**C.** It will not migrate.
**D.** It will migrate, but in an unpredictable direction.

**33.** The structure of glutamic acid is shown below.




It has the following $pK_a$'s:
-COOH $pK_a = 2.2$
$-CH_2-CH_2-COOH$ $pK_a = 4.7$
$-NH_3^+$ $pK_a = 9.7$
The isoelectric point of glutamic acid is
**A.** between pH's 2 and 3.
**B.** between pH's 3 and 4.
**C.** between pH's 4 and 5.
**D.** between pH's 5 and 6.

## Biological Sciences

**Passage I**
The next few questions refer to the following table.

| Quantity | Formula | Units |
|---|---|---|
| Molarity | moles of solute / L of soln | M |
| Molality | moles of solute / kg of solvent | m |
| Wgt per vol (w/v) | g of solute / dL of soln | % |
| Equivalents per litre | moles x charge / L of soln | Eq/L |
| Osmolarity | moles of all particles / L of soln | Osm/L |
| Osmolality | moles all particles / kg of solvent | Osm/kg |

**138**. Normal or isotonic saline (0.85% NaCl) is commonly used to treat dehydration. Which of the following methods would produce normal saline?
**A.** 850 mg of NaCl(s) is weighed out and placed in a volumetric flask, which is then filled with distilled water to the 100 mL mark.
**B.** 850 mg of NaCl(s) is weighed out and placed in a volumetric flask, which is then filled with distilled water to the 1 L mark.
**C.** 8.5 g of NaCl(s) is weighed out and placed in a volumetric flask, which is then filled with distilled water to the 100 mL mark.
**D.** 85 mg of NaCl(s) is weighed out and placed in a volumetric flask, which is then filled with distilled water to the 100 mL mark.

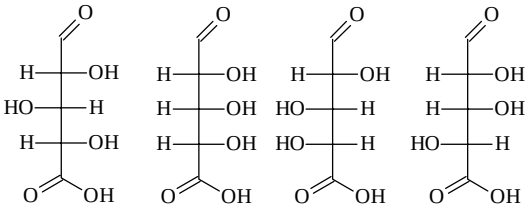
**139**. What is the molarity of the above solution?
**A.** 0.015 M
**B.** 0.15 M
**C.** 1.5 M
**D.** 0.5 M

**140**.What concentration of a glucose solution would also be isotonic?
**A.** 2%
**B.** 3%
**C.** 5%
**D.** 10%

**141**.Red blood cells are mixed in with the glucose solution. What happens to the cells?
**A.** They swell.
**B.** They shrink.
**C.** They remain the same size and shape.
**D.** They change shape.

**142**.A patient's serum is found to have a $Ca^{2+}$ concentration of 0.010%. This is equivalent to
**A.** 0.05 mEq/L
**B.** 0.5 mEq/L
**C.** 0.25 mEq/L
**D.** 5 mEq/L

**Passage II**
Carbohydrates are polyhydroxyaldehydes or polyhydroxyketones. However, in actuality, the carbonyl groups are often present as hemiacetals and acetals. Below are the structures of some carbohydrates.



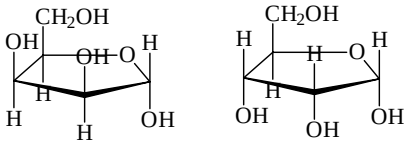
1 2 3 4

**143**.The stereochemical relationship of compounds (3) and (4) is that they are
I. diastereomers
II. enantiomers
III. epimers
**A.** III only
**B.** I and II
**C.** I and III
**D.** II and III

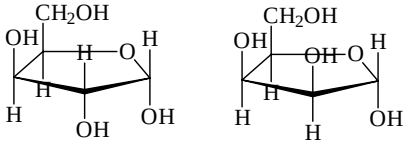
**144**. If the (-) enantiomer of each compound is oxidized by bromine water to yield the corresponding dicarboxylic acid, which will still be optically active?
**A.** 2 and 3
**B.** 3 and 4
**C.** 1 and 2
**D.** 1 and 4

**145**. To convert these compounds to riboses (five-carbon sugars), one must
**A.** cyclize the chain by forming a hemiacetal with the C-4 hydroxyl and the C-1 aldehyde.
**B.** oxidize the C-1 aldehyde to a carboxylic acid.
**C.** reduce the C-5 carboxylic acid to an alcohol.
**D.** reduce the C-5 carboxylic acid to an aldehyde.

**146**.Referring to the previous question, when compound 1 is converted to a ribose, the cyclic hemiacetal it forms is
(note from Dr. Ji: It appears A and D are the same compound, this is what it was shown in the test).

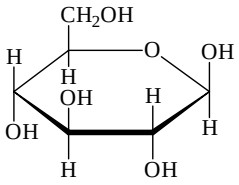


**A** **B**

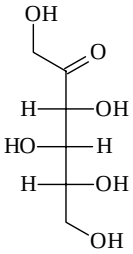


**C** **D**

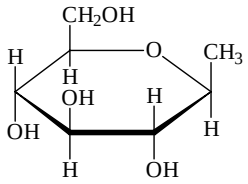
**147**. Which of the following compounds will give a negative Benedict's test?



**A**



**B**

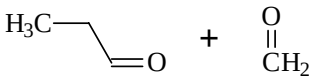


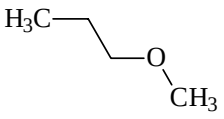
**C**

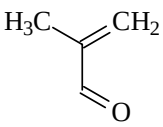
**D**

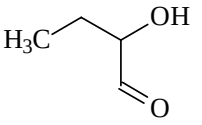
**Questions 158 to 162 are independent of any passage.**
**153**. Which of the following RNA sequences would be transcribed if the sequence of the DNA coding strand were TATTGCATCAA?
**A.** UAUUGCAUCAA
**B.** AUAACGUAGUU
**C.** TTGUTGCUUTU
**D.** AUAAGCAUCAA

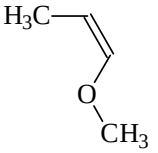
**155**. What is the main product of the following reaction?



**A** 

**C** 

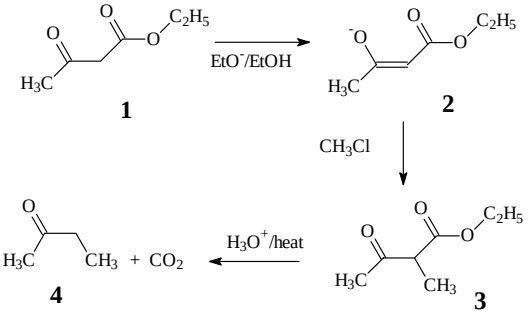
**B** 

**D** 

**156**.In humans, essential fatty acids are required for the synthesis of
**A.** estrogen.
**B.** bile acids.
**C.** purines.
**D.** prostaglandins.

**157**.You have at your disposal benzene, bromine, nitric acid, and sulfuric acid. How would you produce m-bromonitrobenzene?
**A.** m-bromonitrobenzene cannot be made with these materials.
**B.** Brominate the benzene, then nitrate.
**C.** Nitrate the benzene, then brominate.
**D.** Do either B or C.

**Passage IV**
The following questions relate to the reaction sequence outlined below.



**158**.Compound 1 is a/an
A. α-keto carboxylic acid.
B. β-keto carboxylic acid.
**C.** α-keto ester.
**D.** β-keto ester.

**159**.The first step in the sequence could be enhanced by
**A.** replacing the hydrogens at the alpha position by two alkyl groups.
**B.** replacing one of the hydrogens at the alpha position by a chlorine atom.
**C.** replacing one of the carbonyl groups with iodine atoms.
**D.** using ethanoate/ethanoic acid instead of ethoxide/ethanol.

**160**.Although sodium methoxide is readily available, it was not used in the first step because
**A.** it is not as strong a base as ethoxide.
**B.** it would cause an undesired transesterification.
**C.** it would be more difficult to hydrolyze a methyl ester than an ethyl ester.
**D.** a hindered base is needed to protect the carbonyl group.

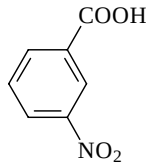
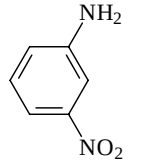
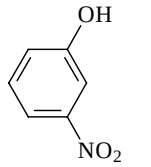
**161**.The second step is a type of reaction known as
**A.** $S_N1$
**B.** $S_N2$.
**C.** electrophilic addition.
**D.** free radical substitution.

**162**.The third step involves
I. protonation of O in the C=O of the ester group
II. $S_N2$ substitution of $OC_2H_5$ by OH
III. heat-induced decarboxylation
**A.** I and II
**B.** I and III
**C.** II and III
**D.** I, II, and III

**163**. What type of reaction does not occur in the sequence?
**A.** Hydrolysis
**B.** Acid-base
**C.** Reduction
**D.** Decarboxylation

**Passage VI**
In various scientific pursuits, it is important to be able to purify substances so that they can be better studied or better used. Common methods of separating substances are extraction, recrystalization, distillation, and chromatography.

A mixture contains the three compounds shown in the table below.

| | | **Solubility** (g/100 ml) | |
|---|---|---|---|
| | | **in $H_2O$** | **in ether** |
| **1** |  | 0.31 | 25.0 |
| **2** |  | 0.11 | 5.5 |
| **3** |  | 3.02 | 106 |

**171**.The mixture is dissolved in a small amount of ether. To this is added an equal volume of 0.01 M $HCl_{(aq)}$. After shaking, two layers are formed: an aqueous layer and an ether layer. The layers are then separated. Which of the compounds will be found in the aqueous layer?
**A.** 1 only
**B.** 2 only
**C.** 3 only
**D.** 2 and 3

**172**. To the ether layer is added an equal volume of 0.01 M $NaOH_{(aq)}$. Again, two layers are formed. After separating them, which of the compounds will be found in the aqueous layer?
**A.** 1 only
**B.** 3 only
**C.** 1 and 3
**D.** 2 and 3

**173**.This aqueous layer is evaporated to dryness leaving a solid residue of mass 0.31 g. Ten milliliters of aqueous acid of pH 3 are added. After stirring, the residue is smaller. What is the identity of the residue?
**A.** 1 only
**B.** 2 only
**C.** 3 only
**D.** 1 and 3

**174**.In extractions, the distribution constant is the ratio of the concentrations of a particular species between two solvents at equilibrium. If the distribution constant for an organic acid (HA) between chloroform and water is 100, i.e. $[HA]_{CHCl_3}/[HA]_{H_2O} = 100$, and the dissociation constant of the acid in water is $10^{-5}$, increasing the pH of the aqueous phase from 4 to 10 will have what effect on the quantity of HA in the chloroform phase? (Assume HA does not dissociate or dimerize in the chloroform phase.)
**A.** The quantity is reduced to less than half of what it was.
**B.** The quantity is reduced but remains more than half of what it was.
**C.** The quantity is increased but is not more than double what it was.
**D.** The quantity is more than double what it was.

**175**. For a species that is distributed between an aqueous phase and an organic extraction phase, the quantity extracted by the organic phase is
I. larger at higher temperatures if the solubility in both layers remains unchanged
II. larger if the total volume of the organic phase is used in portions rather than all at once
III. larger if the species is weakly basic and an acidic aqueous phase is used
**A.** I is correct.
**B.** II is correct.
**C.** III is correct.
**D.** II and III are correct.

**176**.A mixture of toluene (methyl benzene) and aniline (amino benzene) is subjected to liquid column chromatography with alumina ($Al_2O_3$) as the solid phase. Which is most likely to occur?
**A.** Toluene will be eluted first since it has a lower boiling point.
**B.** Separation will not occur since the molecules are about the same size.
**C.** Aniline will be eluted first since it is more polar than toluene.
**D.** Toluene will be eluted first since it is less polar than aniline.

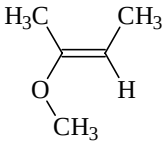
**Questions 192 to196 are independent of any passage.**

**188**.An infrared absorption spectrum is obtained from a compound known to have a hydroxyl group and a carbonyl group. Absorption due to hydroxyl group O-H bond stretching occurs at 3,620 $cm^{-1}$. At what wavenumber would absorption due to C=O stretching likely occur at?
**A.** 3,620 $cm^{-1}$
**B.** 7,200 $cm^{-1}$
**C.** 1,700 $cm^{-1}$
**D.** 9,560 $cm^{-1}$

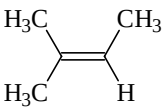
**191**.Cholesterol is a precursor in the biosynthesis of all of the following except
**A.** aldosterone.
**B.** cortisol.
**C.** endorphins.
**D.** testosterone.

**Passage VIII**
Alkenes are characterized by C=C bonds. As such, they are subject to electrophilic addition reactions. Most electrophilic additions obey Markovnikov's rule; however, there are some exceptions. Examples of alkenes are shown below.

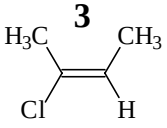
**1**



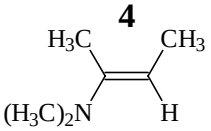
**2**



**3**

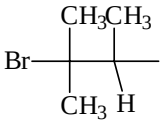


**4**

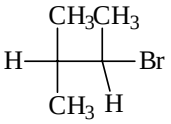


**192**. When HBr adds to compound 2 above, the main product is

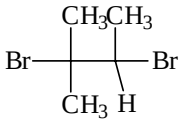
**A**



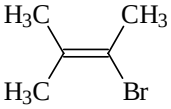
**B**



**C**

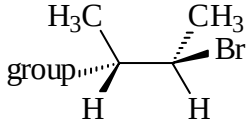


**D**



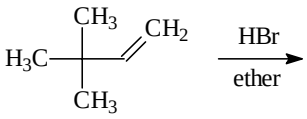
**193**.What is the order of reactivity of the compounds above to electrophilic addition of HBr?
**A.** 1 > 2 > 3 > 4
**B.** 3 > 1 > 4 > 2
**C.** 4 > 1 > 2 > 3
**D.** 2 > 4 > 1 > 3

**194**.Which of the compounds is most likely to form an addition product with the general structure shown below?

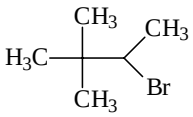


**A.** Compound 1
**B.** Compound 2
**C.** Compound 3
**D.** Compound 4

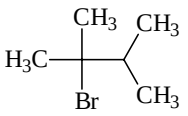
**195**. What is the major product of the following reaction?



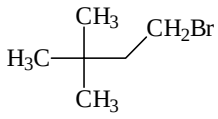
**A**



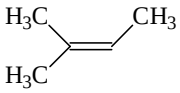
**B**



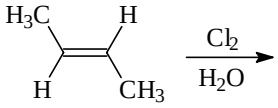
**C**



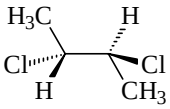
**D**



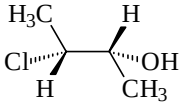
**196**.What is the major product of the following reaction?



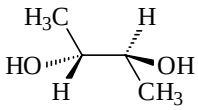
**A**



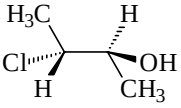
**B**



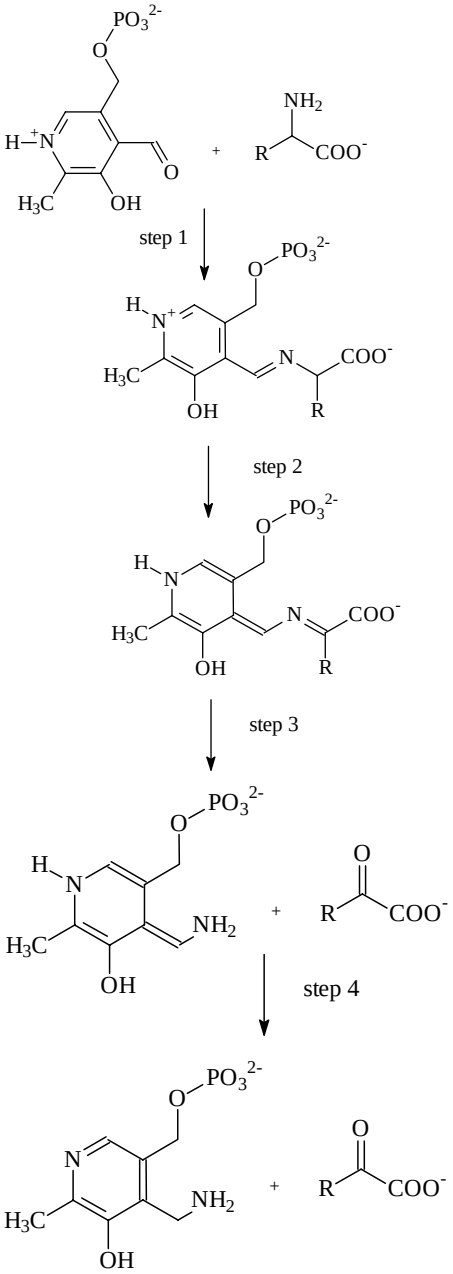
**C**



**D**



**Passage X**
Reactions in living systems have basically the same mechanisms as those carried out in laboratories. To make reactions proceed more rapidly, enzymes take the place of heat and inorganic catalysts. Also, these enzymes allow only specific reactions to occur and not numerous other possible reactions.
An important metabolic pathway in the catabolism of proteins is the transamination of amino acids. Tansaminations use pyridoxal phosphate, a derivative of vitamin $B_6$, as cofactor. Part of this pathway is shown below.




**203**.Which of the following is/are true?
I. Pyridoxal phosphate has an aromatic ring.
II. Pyridoxal phosphate has a net positive charge.
III. Pyridoxal phosphate has an ester linkage.
**A.** Only III is true.
**B.** I and II are true.
**C.** II and III are true.
**D.** I and III are true.

**204**. Step 1 involves
**A.** condensation.
**B.** nucleophilic addition followed by elimination of water.
**C.** decarboxylation.
**D.** an aldol reaction.

**205**. Step 2 involves
**A.** hydration.
**B.** oxidation.
**C.** decarboxylation.
**D.** deprotonation of an acid followed by bond rearrangements.

**206**. Step 3 involves
**A.** hydrolysis.
**B.** oxidation.
**C.** decarboxylation.
**D.** hydration.

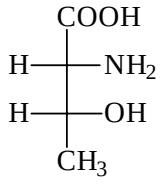
**207**. Step 4 involves
**A.** condensation.
**B.** tautomerization.
**C.** phosphorylation.
**D.** an aldol reaction.

**208**.The overall effect of this pathway is that
**A.** An amino acid is oxidized to an b-keto acid.
**B.** An amino acid is reduced to an b-keto acid.
**C.** An amino acid is oxidized to an a-keto acid.
**D.** An amino acid is reduced to an a-keto acid.

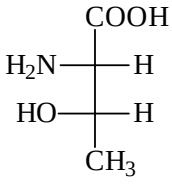
**209**.This pathway actually carries on for many more steps. What is likely to occur further along the pathway?
**A.** Pyridoxal phosphate is regenerated
**B.** Oxidative phosphorylation
**C.** Substrate-level phosphorylation
**D.** Glycolysis

**Questions 215 to 219 are independent of any passage.**
**210**.Which of the following molecules are diastereomers?

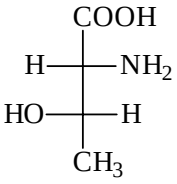
**1**



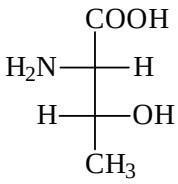
**2**



**3**



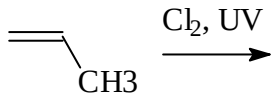
**4**



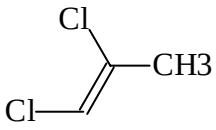
**A.** 1 and 2; 3 and 4
**B.** 1 and 3; 1 and 4; 2 and 3; 2 and 4
**C.** 1 and 4; 2 and 3;

**D.** 1 and 3; 1 and 4; 2 and 4

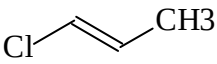
**214**.What is the major product of the following reaction?



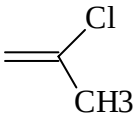

**A.**



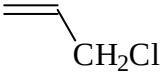

**B.**




**C.**




**D.**




**STOP.** IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK. YOU MAY GO BACK TO ANY QUESTION IN THE BIOLOGICAL SCIENCES TEST BOOKLET.

**END OF MCAT EXAM**